

# **EXHIBIT G**

Bruce and Janice Rhyne, his wife, )  
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 Plaintiffs, )  
 )  
 vs. ) No. 0228  
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 U.S. Steel Corp., et al., )  
 )  
 Defendants. )

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As previously discussed, the benzene content of Varsol and other petroleum-derived solvents has been extensively investigated. Some have reported ranges in benzene content from 1,000 to 10,000 ppm, while others have maintained that levels have been below 100 ppm since the late 1970s. Considering the disparate reports of the benzene content of fresh (clean, virgin) mineral spirits, in predicting Mr. Rhyne's exposures while using the fresh mineral spirits in the open pail, I did the calculations using three concentrations of benzene: low at 50 ppm, medium at 500 ppm, and high at 1,000 ppm. If he spent 1 hour each day soaking then brushing the parts with the Varsol, on the days when he used fresh mineral spirits, the 1-hour average benzene exposure when he worked with the medium (500 ppm) benzene content fresh mineral spirits was predicted to be 50th percentile (median) of 19 mg/m<sup>3</sup>, interquartile confidence interval is 9.7 mg/m<sup>3</sup> to 37 mg/m<sup>3</sup> (6 ppm, range 3.0 – 11.6 ppm). For the low benzene content, his 50<sup>th</sup> percentile value is 5.8 mg/m<sup>3</sup>, range 3 – 11 mg/m<sup>3</sup> (1.8 ppm, 0.9 – 3.4 ppm). For the high benzene content mineral spirits, the 50<sup>th</sup> percentile value is 34 mg/m<sup>3</sup>, range 17 – 66 mg/m<sup>3</sup> (10.6 ppm, range 5.3 to 20.6 ppm).

The benzene content of fresh mineral spirits decays as the solvent is used for cleaning and the benzene vaporizes. Nicas et al. (2006) reported that in a simulation study of parts washing with mineral spirits, the benzene content of the solvent decreased at an exponential rate such that about 50% remained after 5 hours of use.<sup>243</sup> Assuming he used the same bucket of Varsol a second day, using that rate of benzene loss as an approximation for Mr. Rhyne's use of Varsol in the parts cleaning with the open pail, the solvent in the pail on a second day of cleaning would contain about 50% the original benzene content. His benzene exposure would be reduced by half when he used the lower benzene content (the day old) Varsol so his exposure for the 1-hour period of soaking and cleaning would be 3 ppm (range 1.5 to 5.8 ppm) if the fresh Varsol contained 500 ppm benzene; 0.9 ppm (range 0.45 to 1.7 ppm) for the low (100 ppm) benzene Varsol; and 5.3 ppm (range 2.6 to 10.3 ppm) for the high benzene content Varsol.

### ***Kroil***

Ice condenser work only took place during outages. In the early 1990s, if the outage was 60 days, 40 days would be spent unloading condenser ice baskets; if the outage was 20 to 30 days, 20 to 24 days would be spent unloading ice baskets. Loading took much less time; he would unload 18 to 20, 48-foot tall ice baskets a day. Each unit had an outage every 18 months. Oconee had 3 units, Catawba 2 units, and McGuire 2 units; while assigned to the Catawba Plant, he would go out with crews to other plants for outages. He was at either Catawba for about 4 months, McGuire for 30 days or Oconee for 30 days.

Mr. Rhyne recalled working with Kroil while at Duke Energy, specifically while working at the Catawba plant from the early 1990s until he became a supervisor in 1998. He used Kroil to break

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<sup>243</sup> Nicas M, Plisko MJ, and Spencer JW. 2006. Estimating benzene exposure at a solvent parts washer. *Journal of Occupational and Environmental Hygiene*, 3(5):284-291.

apart ice condenser vibrators, of which there were approximately 70. He would work on them for 40 hours, using Kroil for the entire 10-hour day.

As of 2005, a material safety data sheet (MSDS) from Kroil reported its composition as Severely Hydrotreated Petroleum Distillates, 30-50% (CAS 64742-52-5); Light Petroleum Distillates, 30-50% (CAS 64742-95-6/64742-88-7/64742-47-8); Aliphatic Alcohols 1-5%, Glycol Ether 111-76-2, 1-5%; Proprietary Ingredients, 5-15% (CAS 78-92-2/123-42-2). In a summary table by the 2008 Williams Study, the historical benzene content of petroleum distillate products known as VM&P naphtha, Stoddard Solvent, and Mineral Spirits was reported to range from 0.01 to 0.2% (100 to 2000 ppm) over the time period 1975 to 2002.<sup>244</sup> One hour personal exposures from the use of mineral spirits ranged from <0.006 to 0.44 ppm benzene. In the time period when Mr. Rhyne used this product (1990-1998), the benzene content of petroleum derived solvents reportedly ranged from 100 to 2,000 ppm. I determined the range of Mr. Rhyne's benzene exposures to be 0.01 to 1 ppm with a midrange value of 0.5 ppm for the duration of each use of Kroil.

#### *Marvel Mystery Oil*

Mr. Rhyne used Mystery oil during the outages at Catawba when he conducted maintenance work on the ice baskets. The Mystery Oil was used as a lubricant for the vibrator to keep them from freezing up. He worked as a maintenance mechanic from 1986 until he became a supervisor in 1998. They would use ten ounces per oiler, each vibrator had an oiler, and they had 16 vibrators running at each time. They would unscrew the top of the oiler and use a funnel to pour in the Marvel Mystery Oil. The capacity of each oiler was 10 ounces.

As of 1985, Marvel Mystery Oil was reported to contain mineral spirits (30%); and naphthenic base oil distillate (67%). A 1995 MSDS disclosed mineral oil, petroleum distillate solvent refined mild, heavy naphthenic (IARC Carcinogen) petroleum luboil (<75%); mineral oil petroleum distillate solvent dewaxed severe, heavy naphthenic /petroleum lubrication oil < 75%; Stoddard Solvent /mineral spirits <30%. Later safety data sheets (1998, 2000, 2001) report petroleum lubricating oil (CAS 64741-96-4) <75%; mineral spirits (CAS 8052-41-3) <30%, and chlorinated hydrocarbons (CAS 61788-76-9) <0.2%. In the time period when Mr. Rhyne used this product at Catawba (1986-1998), the benzene content of petroleum derived solvents reportedly ranged from 100 to 2,000 ppm. As is the case for other such products, I determined that the range of Rhyne's benzene exposures to be 0.01 to 1 ppm with a midrange value of 0.5 ppm for the duration of each use of the Marvel Mystery Oil.

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<sup>244</sup> Williams et al., 2008, previously cited.

timeframe of 2000s. Mr. Rhyne left work in May of 2015, received 6 months of short-term disability and then went on long-term disability.

<b>Table 3 Daily Average Benzene Exposure by Product and Facility</b>		
<b>Process/Product</b>	<b>Daily Exposure Midpoint (ppm)</b>	<b>Daily Exposure Range (ppm)</b>
<b>Kutzit</b>		
Home use	0.04	0.03 – 0.06
East Lincoln High School	Not determined	–
Setzer's 1974	1.22	–
Setzer's 1975	0.005	–
Duke Energy – Maintenance	0.024	0.002 – 0.048
<b>Rust Penetrant Liquid Wrench</b>		
Home use	0.01	–
East Lincoln High School	0.075	0.004 – 0.25
Setzer's	0.02	0.001 – 0.07
Duke Energy – Pipe Fab Shop		
LW containing 3% benzene	1.5	1.3 – 1.7
LW containing 5% benzene	2.5	2.17 – 3.02
LW containing 7% benzene	3.5	3.2 – 3.8
<b>Safety-Kleen Mineral Spirits Parts Washers</b>		
East Lincoln High School	0.21	0.11 – 0.41
Setzer's	0.05	–
Duke Energy – Pipe Fab Shop	0.82	0.41 – 1.65
Duke Energy – Maintenance	0.2	0.11 – 0.38
<b>Mineral Spirits Cleaning</b>		
Duke Energy – Maintenance	0.56	0.34 – 1.09
<b>Spotcheck</b>		
Duke Energy	Not determined	–
<b>Tap Magic/Rapid tap</b>		
Duke Energy	Not determined	–
<b>CRC products</b>		
Duke energy – Maintenance [10 ppm benzene]	0.007	0.003 – 0.013
Duke energy – Maintenance [100 ppm benzene]	0.07	0.04 – 0.13
<b>Kroil</b>		
Duke Energy – Maintenance	0.5	0.01 – 1.0
<b>Marvel Mystery Oil</b>		
Duke Energy – Maintenance	Not determined	–

## DERMAL EXPOSURES

Mr. Rhyne stated that he had skin contact with some materials he worked with, particularly Liquid Wrench while he was beveling and cutting metal parts. The potential for skin exposure to

0.38 ppm. The corresponding cumulative benzene exposure is 1.4 ppm-years (range 0.77 – 2.66 ppm-years).

He also used a Safety-Kleen parts washer in the Pipe Fab shop. Mr. Rhyne reported that out of the 8 hour per day/40 hour week, he spent 50% of his time cleaning parts in the Safety-Kleen parts washer in the fab shop. His daily average 8 hour TWA exposure was 0.82 ppm (range 0.41 – 1.65 ppm), corresponding to 2.49 ppm-years (range 1.23 – 4.95 ppm-years).

#### ***Varsol (mineral spirits) Cleaning***

Mr. Rhyne recalled using Varsol on the pipefitting crew to clean items such as bolting and fasteners. He recalled going to the painters at Duke to get the Varsol. His daily average benzene exposure from this source was 0.56 ppm (range 0.34 – 1.09 ppm). His cumulative benzene exposure was 2.8 ppm-years (range 1.7 – 5.45 ppm-years).

#### ***CRC Products***

Mr. Rhyne recalled using CRC about 30% of the time for parts cleaning from 1985 to 1990s “and up to maybe 2000” timeframe. If the CRC product contained 100 ppm benzene, the predicted 50th percentile daily exposure is 0.07 ppm, range 0.04 – 0.13 ppm. If the benzene content was 10 ppm, the predicted 50th percentile daily average was 0.007 ppm, range 0.003 – 0.013 ppm. The corresponding cumulative exposures are 0.49 ppm-years (range 0.21 – 0.91 ppm-years) for the 100 ppm benzene cleaners; 0.049 ppm-years (range 0.021 – 0.091 ppm-years) for 10 ppm benzene cleaners.

#### ***Kroil***

Mr. Rhyne worked with Kroil at the Catawba plant from the early 1990s until he became a supervisor in 1998. He used Kroil to break apart ice condenser vibrators, of which there were approximately 70. He would work on them for 40 hours, using Kroil for the entire ten hour day. I estimated his daily exposure at 0.5 ppm, range 0.01 – 1 ppm. The corresponding cumulative benzene exposures are 3.5 ppm-years (range 0.07 – 7 ppm-years).

**Table 4** Cumulative Benzene Exposure by Product and Facility

Process/Product	Cumulative Exposure Midpoint (ppm-years)	Cumulative Exposure Range (ppm-years)
<b>Kutzit</b>		
Home use	0.24	0.18 – 0.36
East Lincoln High School	Not determined	–
Setzer's 1974	1.22	–
Setzer's 1975	0.05	–
Duke Energy – Maintenance	0.31	0.03 – 0.62
<b>Rust Penetrant Liquid Wrench</b>		
Home use	0.1	–
East Lincoln High School	0.15	0.08 – 0.5
Setzer's	0.048	0.002 – 0.142
Duke Energy – Pipe Fab Shop		
LW containing 3% benzene	3.75	3.25-4.25
LW containing 5% benzene	6.25	5.42-7.55
LW containing 7% benzene	8.75	8.00-9.50
<b>Safety-Kleen Mineral Spirits Parts Washers</b>		
East Lincoln High School	0.42	0.22 – 0.82
Setzer's	0.1	0.06 – 0.2
Duke Energy – Pipe Fab Shop	2.49	1.23 – 4.95
Duke Energy – Maintenance	1.4	0.77 – 2.66
<b>Mineral Spirits Cleaning</b>		
Duke Energy – Maintenance	2.8	1.7 – 5.45
<b>Spotcheck</b>		
Duke Energy	Not determined	–
<b>Tap Magic/Rapid tap</b>		
Duke Energy	Not determined	–
<b>CRC products</b>		
Duke Energy – Maintenance		
10 ppm benzene	0.049	0.021 – 0.091
100 ppm benzene	0.49	0.21 – 0.91
<b>Kroil</b>		
Duke Energy – Maintenance	3.5	0.07 – 7.0
<b>Marvel Mystery Oil</b>		
Duke Energy – Maintenance	Not determined	–
<b>Total</b>		
Low (3% benzene LW; 10 ppm benzene CRC)	17.07	8.86 – 28.37
Medium (5% benzene LW; 10 ppm benzene CRC)	19.57	13.04 – 33.5
High (7% benzene LW; 100 ppm benzene CRC)	21.63	13.8 – 34.44

## CONCLUSIONS

In addition to the opinions expressed in this report, I have come to the following conclusions:

Exposure to benzene from use of Kutzit:

Mr. Rhyne's cumulative benzene exposure was 1.82 ppm-years (range 0.05 – 1.22 ppm-years) from his use of Kutzit.

Exposure to benzene from use of Liquid Wrench rust penetrant:

Mr. Rhyne's cumulative benzene exposure was 6.55 ppm-years (range 0.1 – 6.25 ppm-years) from his use of Liquid Wrench containing 5% benzene.

Exposure to benzene from CRC cleaners:

Mr. Rhyne was exposed to 0.05 ppm-years (range 0.02 – 0.09 ppm-years) benzene for cleaner containing 100 ppm benzene; 0.49 ppm-years (range 0.2 – 0.9 ppm-years) for cleaner containing 10 ppm benzene.

Exposure to benzene from mineral spirits parts washers:

Mr. Rhyne was exposed to 4.41 ppm-years (range 0.1 – 2.49 ppm-years) benzene from this source.

Exposure to benzene from mineral spirits in open buckets:

Mr. Rhyne was exposed to 2.8 ppm-years (range 1.7 – 5.4 ppm-years) benzene from this source.

Exposure to benzene from Kroil:

Mr. Rhyne was exposed to 3.5 ppm-years (range 0.07 – 7.0 ppm-years) benzene from this source.

The total mean cumulative benzene exposures Mr. Rhyne experienced ranged from 8.86 to 34.44 ppm-years with a midpoint estimate of 19.77 ppm-years. This exposure is an underestimate of Mr. Rhyne's total exposure because it does not include significant dermal exposures he experienced, particularly during the use of Liquid Wrench as a lubricant while machining parts.

I hold these opinions and conclusions to a reasonable degree of scientific certainty. If additional information becomes available, I reserve the right to modify, amend, or supplement this report.



Robert F. Herrick, Sc.D., CIH, FAIHA

September 17, 2019

Appendix